THE SYSTEMIC APPROACH TO TEACHING AND LEARNING: WATER CHEMISTRY

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ABSTRACT

The systemic approach to teaching and learning (SATL) has been developed during the last decade 1-7). SATL techniques have been implemented and evaluated in many different disciplines (chemistry, biology, physics, and math) in all educational levels, but the major SATL applications have been reported on chemistry topics in secondary and tertiary education (2-4). Experimental evidence collected in Egyptian schools is presented to illustrate the efficacy of SATL methods on students' academic achievements (2, 3). We present here a specific chemically-related example of the application of SATL methods in teaching the chemistry of water. *[AJCE, 1(2), July 2011]*

INTRODUCTION

After the wide spread of the systematization in various disciplines and activities including tourism, commerce, economy, security, education etc. and after globalization became a reality that we live and survive with its positive and negative impacts on our life, SATL became a must. It verifies the major goals of educational system and proceeds towards systemic thinking and continuous growth of knowledge that is referred to as quality of education. Thus, the future of science education must reflect a flexibility to adapt to rapidly changing world needs. It is our thesis that a systemic view of science with regard to principles and their internal (to science) interactions as well as the interactions with human needs will best serve the future world society.

Constructivist and meaningful learning theories are the basis of SATL (8, 9). The basic goal of systemic approach is the achievement of meaningful learning by students. Meaningful learning was described by Ausubel as the formulation of non-arbitrary relationships between ideas in the learners' mind (8). In rote learning, learners are able to neither construct relationships between concepts nor integrate new concepts to their prior knowledge in their cognitive structure. In contrast, deep or meaningful learning was described by Novak as the learners deal with a learning task by attempting to form relationships between newly and previously learned concepts (9). Within the frame of these theories, effective teaching connects isolated ideas and information with global concepts and recognizes that meaning is personal and unique, and that students' understandings are based on their own unique experiences.

The use of systemics, in our view, will help students to understand interrelationships between concepts in a greater context of a point of view, once achieved, that ultimately should prove beneficial to future citizens. The key teaching device in the SATL technique is the Systemic Diagram (SD) which is a two-dimensional representation of the concepts that are to be taught to, or learned by, the students in the class.

In our previous publication (7) we have described the uses of the SATL techniques in building teaching unites in organic chemistry via systemic teaching strategy (STS). It was stated previously that any unit to be taught using SATL methods involves the building of a systemic diagram (SD_0) that has been determined as the starting point of the unit; SD_0 incorporates the prerequisite concepts. The SD_0 assures that all students will have the same starting point as they progress through the entire set of systemic diagrams. The unit ends with a final systemic diagram (SD_f) in which all the relationships between concepts in the unit that have been taught to the student are known (Fig1). From SD_0 through SD_f we encounter several smaller systemics with known and unknown relationships (SD_1, SD_2, etc).

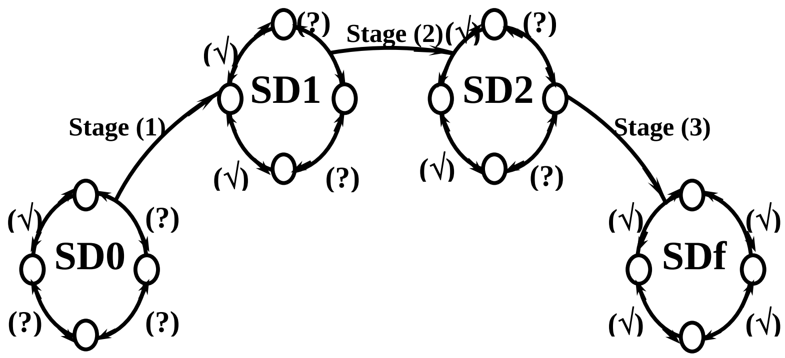

Fig. 1-Systemic Building Strategy

Linearly based unites in chemistry (and other subjects) were converted into systemically-based units according to a scheme stated in our previous publication (7).

SATL—Water Chemistry: a specific example

We present here a specific chemically-related example of the application of SATL methods. We use water—the chemistry of Water--to illustrate how a subject can be organized systemically to help students to fit new concepts into their own cognitive structure. The details of the transformation of the linear approach usually used to teach water such as the separate physico-chemical relationships among other related environmental relations are shown in fig. 2, which represents a linear approach to teaching water chemistry.

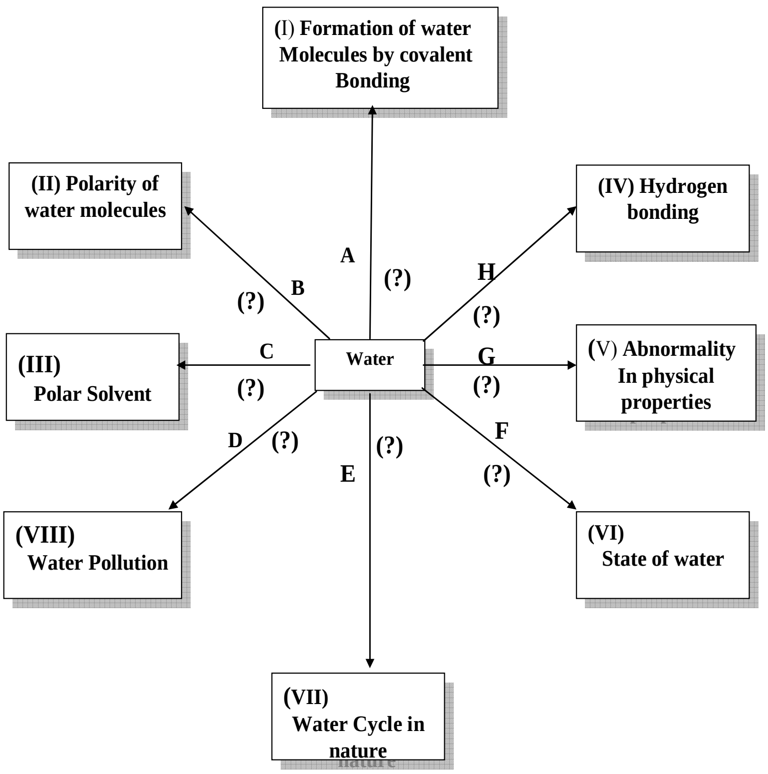

Fig (2): Separate Physical Relations

The physico-chemical relationships (covalent bonding, polarity of water molecules, polarity of water solvent, hydrogen bonding, abnormalities in physical properties, state of water & water in our environment, Water cycle, Water pollution , etc.) are summarized in the diagram Fig. 2, which looks like a series of linear relationships are connected by water . We can illustrate the linear relationships that appear in Fig. 2 in the following systemic diagram (SD0)., shown as Fig.3.

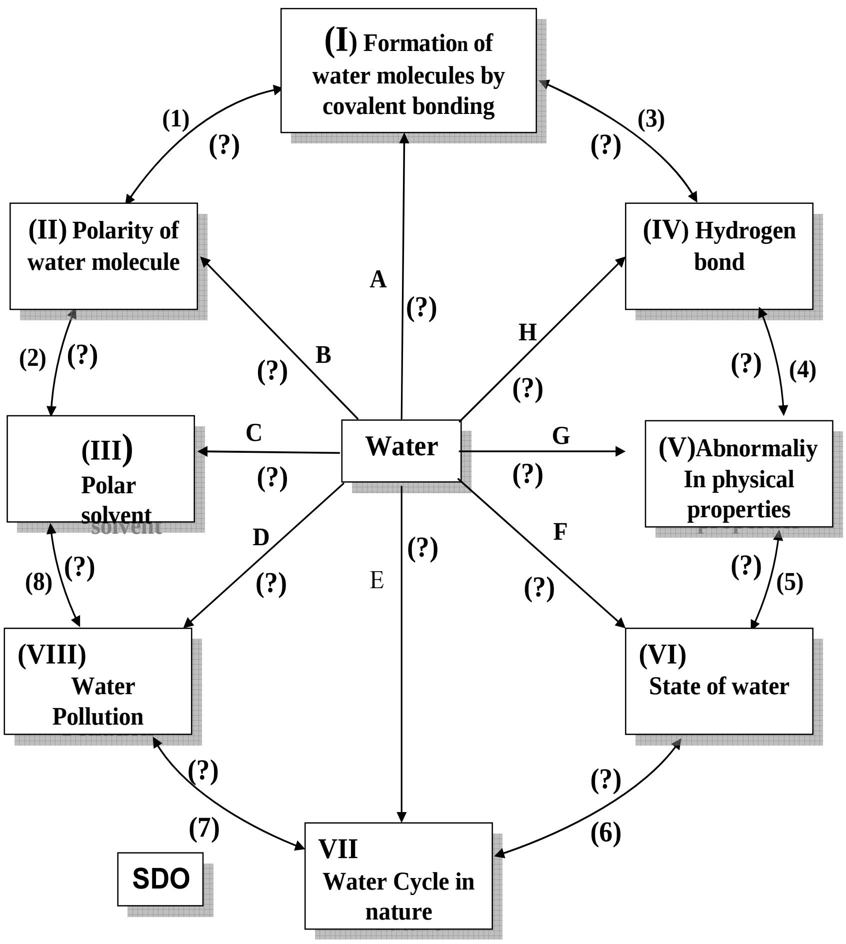

Fig. 3. SD_0 represents some of the major properties of water..

In the systemic diagram SD_0 (Fig. 3.), all the relationships are undefined (to be learned by the students). The undefined relationships are developed systemically. After studying the nature of chemical bonding in a water molecule as polar covalent bond (A) and its relation to the following properties (i) Polarity of water molecules (B) and (ii) uses of water as a polar solvent (C), we can modify SD_0 in fig 3 to SD1 in fig.4 by adding properties (A-C) and relations (1-2).

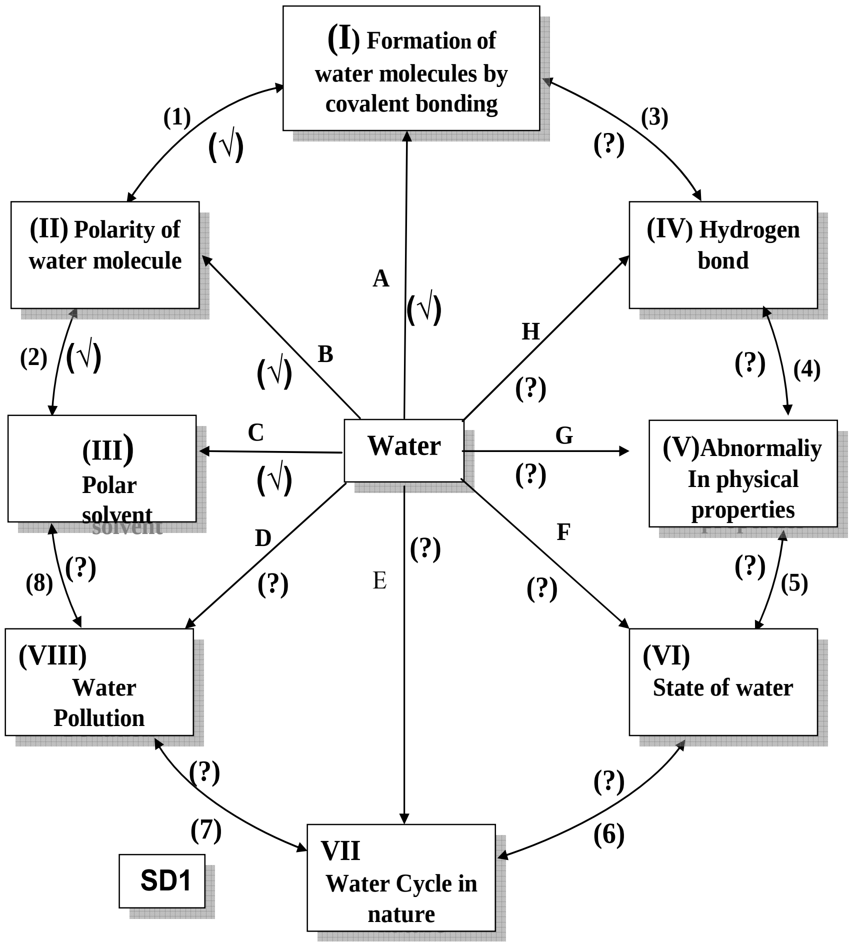

Fig. 4. SD_1

In SD_1, Fig. 4, we still have undefined properties (D-F) and relationships among 3-8. These will be clarified after studying the remainder of the unit. After studying abnormalities in physical properties (G) (eg elevation of boiling point, and depression in freezing point), hydrogen bonding (H) and their relationship to covalent bonding, we can modify SD1, fig.4, to SD2 in Fig.5 by adding properties (G, H) and relations (3, 4).

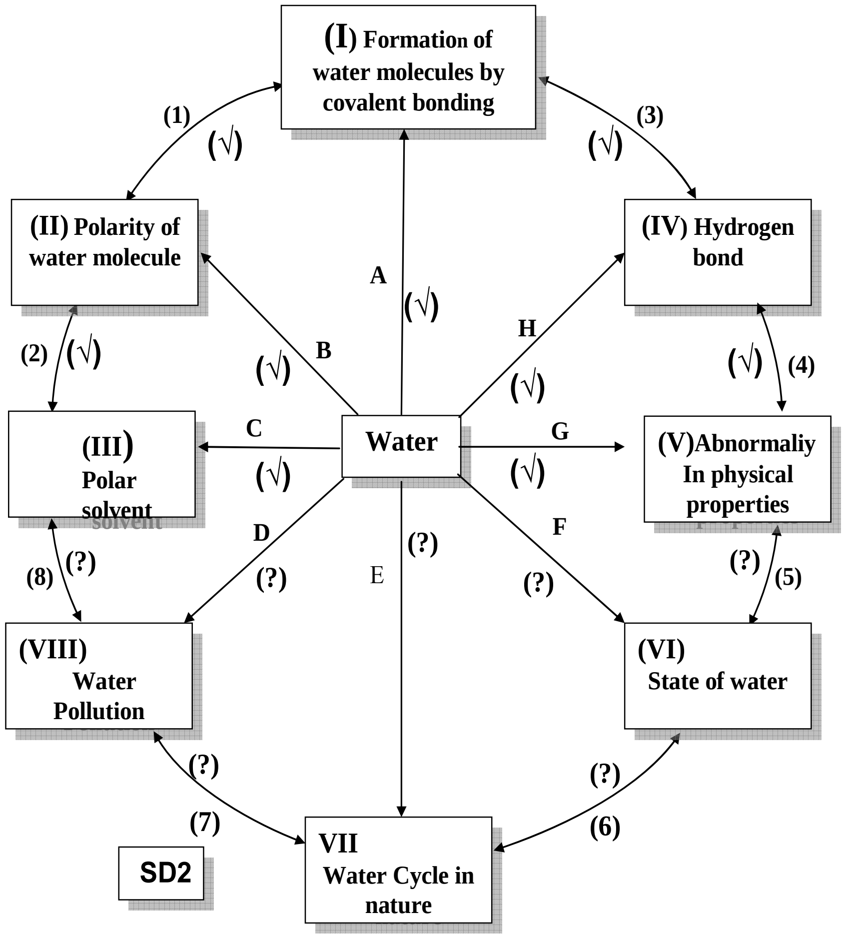

Fig 5. SD2

After studying the state of water (F) and its relation to water cycle in nature (E), and water pollution (D), we can modify SD2 in fig.5 to SDf in Fig.6 by adding properties (D-F) and relationships (5-8).

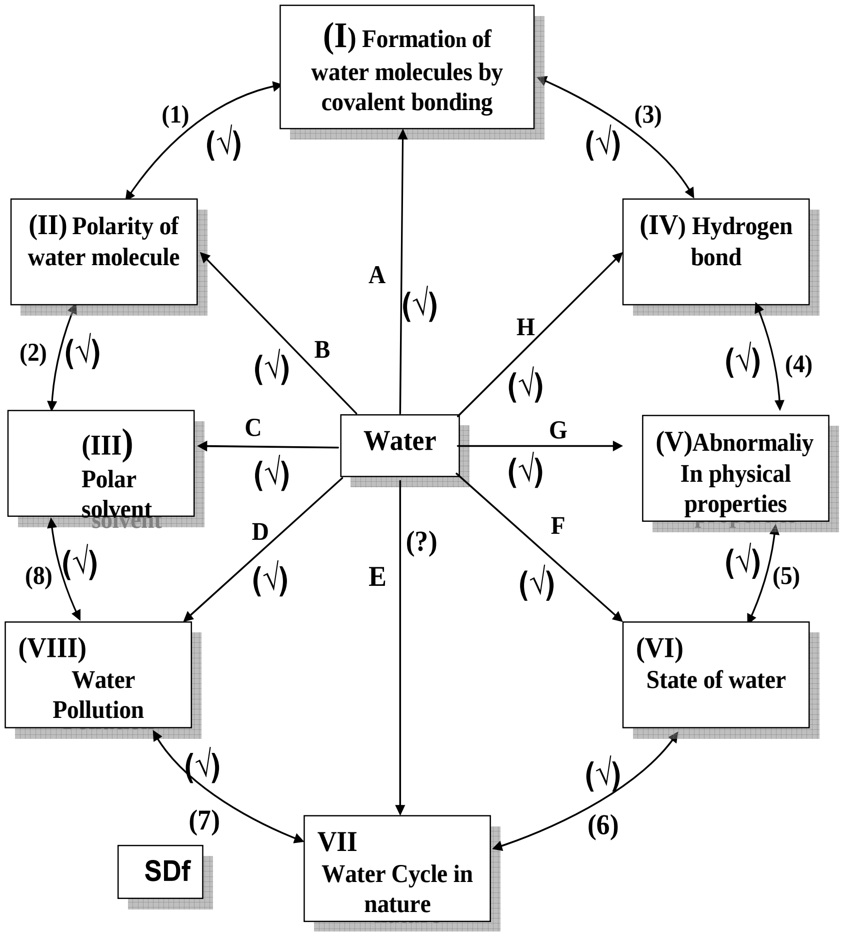

Fig. 6. SDf in which all the relations (1-8), and properties (A - H) are known.

SUMMARY

From the scenario of teaching this unit, we extract the following general observations. We started teaching the unit by using the systemic diagram SD0 that has been determined by the teacher as the starting point of the unit, and we ended with the systemic diagram SDf that defines the terminal point of the unit. Between the two systemics we pass through the systemic diagrams SD1,SD2.

The systemic diagrams involved using the approach to study water are similar except that the number of known relationships (√) and the unknown ones (?). As we proceed in teaching the unit, the unknown relationships become diminished while the known ones increase until we reach the end where all the relationships become known as indicated in SDf in Fig. 6.

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